RAIL ROUTING – CURRENT PRACTICES FOR SPENT NUCLEAR FUEL AND HIGH-LEVEL WASTE SHIPMENTS, AND A COMPARATIVE ANALYSIS OF HIGHWAY REGULATORY GUIDELINES APPLIED TO RAIL

A DISCUSSION PAPER

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I. Introduction

The U.S. Department of Energy (DOE) ships highly radioactive materials between former production sites, research reactors, power reactors, storage and other facilities throughout the United States. Two types of highly radioactive materials are spent nuclear fuel and high-level radioactive waste that resulted from reprocessing spent fuel. Transportation of these radioactive materials includes both highway and rail modes. For highway shipments, these materials are subject to specific regulations on routing. The Department of Transportation (DOT) has addressed highway routing requirements in their regulations on the transportation of Class 7 (radioactive) materials. The regulations contain specific requirements for Class 7 material for which placarding is required, and for a "Highway Route Controlled Quantity" of Class 7 material, as defined in 49 CFR 173.403 (1). Regulations on routing, like those for highway shipments of Class 7 material, do not exist for rail transport.

The purpose of the paper is to: 1) describe current rail regulations and practices regarding routing of rail shipments of spent nuclear fuel and high-level waste; 2) identify perspectives and concerns of States/Tribes, Industry, and other involved parties in spent nuclear fuel transport as they specifically relate to rail routing; and 3) compare aspects of the highway routing regulations as they might apply to rail routing.

II. Current Rail Routing System

A. Regulatory Structure

DOT/Federal Railroad Administration

Rail routing of large quantity radioactive materials such as spent nuclear fuel is treated differently from highway routing from a regulatory standpoint. Regulations like those for highway shipments do not exist for rail transport; instead, a shipper and rail carrier normally jointly plan the route considering factors important to service and operational requirements. Physical protection requirements for safeguards and security, specific to routing shipments of spent nuclear fuel and high-level radioactive waste, are covered under DOT 49 CFR 173.22 (c)(2).

Over the past two decades, some stakeholders have proposed that DOT promulgate rail routing guidelines similar to the highway regulations in 49 CFR 397.101 to address rail shipments of certain radioactive materials. Proposed legislation would have required DOT to promulgate rail routing guidelines for spent nuclear fuel and high-level waste shipments. It is unclear how such legislation might change current carrier routing preferences.

To reaffirm the Federal Railroad Administration's (FRA) dedication to ensuring the safe and secure transportation of high-level radioactive waste and spent nuclear fuel, FRA published, in 1998, the *Safety Compliance Oversight Plan for Rail Transportation of High-Level Radioactive Waste and Spent Nuclear Fuel*. The FRA plan addresses several safety compliance oversight tasks, such as operational integrity, emergency response, route infrastructure integrity, and security. Within the operational integrity tasks, item seven (OI-7) addresses track classification in the route selection process. Specifically, task seven identifies that the shipper and carrier will include consideration of the track classification in their route selection process, and that the highest rated track is utilized to the greatest extent possible over the route selected. Task seven further states, "the FRA, DOE, the offeror or agent, and the rail carriers will coordinate during the planning stages of each shipment to ensure that track classification information and criteria are considered in the route selection process". Additionally, under the route infrastructure integrity section of the plan, it states that FRA will continue their existing inspection policy concerning routine track and signal system inspections along designated routes.

Nuclear Regulatory Commission

The Nuclear Regulatory Commission (NRC) has established a system of physical protection requirements for shipments of spent nuclear fuel and high-level radioactive waste. This system is designed to reduce the risk of radiological sabotage or diversion of weapons-grade nuclear materials. Shippers that are NRC licensees are required to send the rail route plan to the NRC, which (as it does for highway) examines physical security considerations in accordance with 10 CFR 73.37.

The NRC has identified five types of route characteristics, within the context of physical security, that receive special consideration when NRC staff review routes (highway or rail) for approval pursuant to 10 CFR 73: (1) routes through highly populated areas; (2) routes that would place the shipment or escort vehicle in a significantly disadvantageous position; (3) routes with marginal safety design features; (4) routes with limited rest and refueling locations; and (5) routes where responses by local law enforcement agencies, when requested, would not be swift or timely.

B. Industry Practices

As the transportation service provider, the rail industry considers multiple factors when routing hazardous cargo, including radioactive material. Typically these factors include safety, starting and ending points; the distance and time in transit, while considering the extent that a shipment utilizes their system; track classification; the amount of traffic (see definition of "key routes" below); and external features such as bridge conditions relative to the weight of the shipment load. The consideration of track class in the route selection process serves to ensure that the highest rated track is utilized to the extent practicable over the route selected.

As an operational practice, it is instructive to note that hazardous cargo is often routed along railroad carrier's routes that have been designated as "Key Routes", as defined in the Association of American Railroads (AAR) Circular OT-55 (most current version). A key route is defined as "any track with a combination of 10,000 car loads or intermodal portable tank loads of hazardous materials, or a combination of 4,000 car loadings of a Poison Inhalation Hazard, flammable gas, Class 1.1 or 1.2 explosives, environmentally sensitive chemicals, spent nuclear fuel or high level radioactive waste over a period of one year". The AAR has recommended specific requirements for key routes that call for: increased use of wayside defective bearing detectors; more frequent track inspections; and minimum track classification used for meeting and passing trains carrying the listed hazards.

C. DOE Practices

As a shipper, DOE considers routing an important logistical aspect of routine transportation planning and operations. In recent campaigns DOE has worked closely with the carrier and other Federal, State, Tribal, and local authorities in early identification of potential routes.

Routing determinations are critically important to DOE, and as a matter of course DOE consults closely with the carrier and affected States in making the final selection. In cases of shipping campaigns where multiple shipments over an extended period of time are scheduled, DOE has often undertaken a routing identification process using its analytical routing tool, Transportation Routing Analysis Geographic Information System (TRAGIS), which contains modules for both highway and rail transport. The purpose of this route identification is to help facilitate transportation planning in conjunction with affected state, local, and tribal authorities, and in preparation of specific campaign transportation plans.

The DOE has established a set of standard transportation practices for Departmental programs to use in planning and executing offsite shipments of radioactive materials. These practices are presented in DOE Manual 460.2-1, *Radioactive Material Transportation Practices Manual.* The Manual includes a section on routing, which addresses the identification and selection of highway and rail transportation routes for

shipments of DOE radioactive materials. In considering rail routing associated with spent nuclear fuel, the Manual points out that DOE or its designated shipper specifies carriers and interchange points between carriers, and that DOE will coordinate routing options with rail carriers and stakeholders. In selecting rail routes, the following factors are considered: (1) distance traveled; (2) the number of interchanges between railroads along the route; (3) the use of higher-class track, for example, "key routes" as defined in AAR Circular OT-55 (most current version); and (4) operational input from carriers. For spent nuclear fuel shipments made under the Nuclear Waste Policy Act, as amended, the Manual references route selection requirements in the draft Request For Proposal to acquire transportation services, or subsequent revisions, and includes DOE responsibility for stakeholder relations and final route approval.

D. State/ Tribal Practices

Unlike Highway Route Controlled Quantity shipments via truck, States have no formal regulatory role in designating routes for rail shipments. The States have been actively involved in the route selection process used by DOE as the shipper for spent nuclear fuel. DOE has, on several occasions in the recent past, successfully consulted with the States on prospective rail shipping routes. This interaction has allowed the States to express specific concerns associated with proposed routes, and through discussions with the shipper and carrier, identify routes acceptable to the State. The States recognize that without a regulatory role their involvement is dependent on DOE's route selection process.

III. Concerns with Current Practices

A. Industry Concerns

From the industry's perspective, voluntary practices, such as those defined in the AAR Circular OT-55 (most current version) for track classification, have been instructive and successful as non-regulatory guidelines for rail routing. These voluntary industry practices are a positive influence on the route selection process. For example, when railroad carriers route hazardous cargo along "key routes" and avoid circuitous routes over lower track class, the shipment moves faster and potentially decreases the probability of an incident en-route. For these industry practices to be fully realized, the rail carriers need to be engaged in the route selection process in a timely manner.

B. DOE Concerns

Although DOT regulations relating to rail routing have not been promulgated, DOE criteria and models do exist to assist in the route selection. An internal DOE evaluation, documented in the report *Best Practices and Findings for DOE Programs Transporting Spent Nuclear Fuel*, January 2003, compared several spent nuclear fuel shipping campaigns to identify best practices in terms of planning activities. The evaluation

identified that different approaches on route selection were taken for specific shipping campaign planning. A suggested best practice for dealing with the complex issue of routing was to emphasize a well-coordinated and integrated planning effort with representatives from State, Tribal and local governments, and carriers. The identified best practices for routing will help to eliminate inconsistencies that can lead to a different set of criteria being applied each time a rail route selection is made. It will also lead to greater operational efficiencies and interaction with groups involved in transportation planning.

C. State/Tribal Concerns

The States' interest in the selection of rail routes for radioactive material shipments derives primarily from their responsibility to protect public health and welfare, as well as property, from the possible effects of transportation accidents involving radioactive material. This responsibility exists regardless of whether there are few or many shipments, and regardless of transportation mode. Given the public scrutiny and concern over the transport of radioactive materials, the States also have an interest in trying to ensure uneventful transport – avoiding even minor accidents and operational errors.

Because their own role is so limited in selecting rail routes, the States' perspective is that DOE, as a major shipper of radioactive materials and as a responsible government agency, should play a central role in the selection of routes for specific rail shipping campaigns.

From the States' perspective, the ideal rail route selection process would achieve four main goals:

1) Promote safety in the selection of routes, and emphasize consultation with affected States and Tribes, as well as rail carriers;
2) Promote public acceptance of the shipping routes by making the Federal government, not the rail carrier, ultimately accountable for route selection;
3) Allow State and local resources (inspections, emergency response, etc.) to be focused by reducing the total number of potential routes; and
4) Give States and communities sufficient time to prepare for shipments along the selected routes.

Though existing practices emphasize DOE coordination with the affected States, that practice has not always resulted in a satisfactory route selection process. The timing of the coordination can be critical in allowing DOE to work with the carrier to identify a route that is acceptable.

Another State consideration is to narrow the number of acceptable routes. Under current regulations, virtually all rail routes could be used for radioactive material shipments. The States' preference would be for a single route to be designated as the primary route. This route would be used for all shipments from a given point to a given destination, barring

some event that interferes with the use of that route, such as an accident, emergency track repair or maintenance, weather, or a security threat. The States' preference is that alternative routes would be identified that would be available only when the primary route is not useable, because of the conditions noted above.

Many States have suggested that the routes for shipments of high-level radioactive materials should take into consideration critical safety factors not included explicitly in Federal regulations such as: minimizing emergency response time; retrieveability of casks in the event of an accident; avoiding difficult-to-evacuate populations; minimizing transit through inclement weather; avoiding "high hazards;" and imposing time-of-day travel restrictions. In addition, avoiding classification yards is also preferred. States would like to review these factors with DOE and its rail carriers in routing discussions. The States believe that once a route is selected it should be reflected in DOE's rail transportation services contract or tender. Specifically, the rail transportation services contract/tender language should require the rail carrier to utilize only these specifically designated routes, and it should clearly articulate the conditions under which route deviations may occur and the duties and responsibilities of the carrier and DOE in the event of a required deviation.

IV. Regulatory Alternative to the Current Rail Routing System

Given the fact that there has been stakeholder interest in promulgating rail routing guidelines similar to the highway regulations, a comparative analysis of the highway methodology to rail routing was undertaken to explore concept feasibility and range of impacts. This section provides a summary of highway routing requirements, results of a comparative analysis, and elements associated with the potential establishment of regulations on rail routing for spent nuclear fuel and high-level radioactive waste.

Summary of Highway Routing Requirements and the DOT Guidelines for Route Selection

The DOT has established specific highway routing requirements for certain radioactive materials. These requirements are codified in 49 CFR 397.101 and 397.103, and are extensively discussed in the January 19, 1981, Federal Register (Docket HM-164, 46 FR 5298). The routing requirements identify "preferred routes" which are defined in the rules as any route designated by a "State routing agency" and any Interstate system highway for which an alternative highway has not been designated by a State agency.

Implementation of the routing regulations for highway route controlled quantity shipments of radioactive materials necessitates a methodology for selecting preferred routes. For this purpose, DOT has developed an approach entitled, *Guidelines for Selecting Preferred Highway Routes for Highway Route Controlled Quantity Shipments of Radioactive Materials, DOT/RSPA/HMS/92-02.* This methodology provides a basis

for State agencies to select routes available within the State. A number of factors can be important in comparing available routes and the methodology provides a systematic treatment of these factors. Overall, determining a route that will minimize radiological impacts is the goal of the process.

The risk comparison factors used in the DOT methodology are categorized as either radiological impacts or non-radiological impacts. Additional factors influencing the risk of radioactive materials transportation include certain actions that have the potential of mitigating exposure to radioactive material. The DOT believes that the primary objective in route selection should be placed on the risk that is associated with the radiological nature of the cargo. Consequently, the following are considered to be primary route comparison factors:

1) Radiation exposure from normal transport;
2) Public health risk from accidental release of radioactive materials; and
3) Economic risk from accidental release of radioactive materials.

Other factors may be useful to consider in the route selection process, but only after careful analysis reveals that alternative routes have essentially the same level of risk, based on the three primary comparison factors. The following are considered secondary comparison factors:

1) Emergency response effectiveness;
2) Evacuation capabilities;
3) Location of special facilities such as schools or hospitals; and
4) Traffic fatalities and injuries unrelated to the radioactive nature of the cargo.

In the DOT process, the primary route comparison factors form the basis for route designation decisions. The remaining secondary factors are used if no clear-cut choice emerges from evaluation of the primary factors, or if unusual conditions exist in the State that increase the importance of one or more of the secondary factors.

Comparative Analysis of the Highway Methodology to Rail Routing

The use of the highway methodology for rail route selection presents a challenge since there are significant operational differences between the two modes of transportation. Rail lines are private property owned by the railroad companies and are fixed in place. Within this context, the movement of spent nuclear fuel and high level waste actually compete with other commodities for service. Additionally, rail lines, particularly high quality mainline track, connect large population centers. The highway routing guidelines, however, serve as a prudent model for rail routing since the highway rules are designed to minimize risk – a primary goal in all activities involving radioactive materials. Specific characteristics of the highway guidelines for routing are discussed below and compared with rail transport. These comparisons are summarized in Table 1.

A network of “preferred routes” has not been established for rail transportation. This concept is really the basis for the highway model in that a defined set of routes is pre-established for highway route controlled quantities of radioactive material. Without a similar point of reference for rail transport, a regulatory approach to rail routing may be problematic to implement. The Association of American Railroads has recommended using designated “key routes” for certain hazardous materials, including spent nuclear fuel and high-level radioactive waste. These key routes have certain characteristics, including the requirements for 1) wayside bearing defect-detectors; 2) main track inspections by rail defect detection and track geometry inspection cars no less than two times each year; and 3) use of Class 2 track or higher. Key routes might be a good analogue for the “preferred” system of highway routes.

For the highway methodology, State routing agencies have been identified as responsible for alternative routing decisions in connection with preferred routes. Given the States’ responsibility for highways within their boundaries, this authority has worked well. However, since the rail infrastructure is owned and operated by private rail companies, it is much more difficult to establish a rail routing authority responsible for alternative preferred routes. The States would not be in a position to designate a lead agency for rail routing decisions, since they have no authority over the privately owned rail lines. An independent entity serving as a rail routing authority presents a complicated problem. Specific route designations made outside of the rail industry’s business operations have the potential to lessen flexibility and limit the dynamics of rail service.

The highway routing guidelines have been viable, partly because the nation’s Interstate highway system is large and intricate. It offers numerous opportunities from a particular origin to a specific destination, using highways that are comparable in quality (i.e., divided highways, limited access). This flexibility is a key characteristic. The rail network is comparatively smaller and less intricate, and only a few railroad companies operate cross-country rail lines. This relatively smaller network does not provide the flexibility inherent in the highway-preferred routes, which includes the Interstate highway system, supplemented by State and U.S. highways. This in turn means fewer potential alternatives available, especially considering that DOT recognizes the shortest time in transit as being a primary consideration.

There is a fundamental business difference between highway and rail transport. In considering decisions regarding alternative routes, rail companies have to consider overall business operations. Actions that constrain the volume of traffic on specific rail systems can have a large negative impact. Routing of radiological material shipments has to be taken within this larger context. The business considerations further reduce the level of flexibility required for alternative routing decisions. If rail routing requirements were implemented, the designated lead agency would need to consult closely with the affected railroads as part of the process.

If a regulatory routing regime were developed for rail, both the primary and secondary risk comparison factors that are taken into account with the DOT highway routing model

could likely be useful in determining rail routes. However, there are other factors, such as rail traffic, number of interchanges, track classification, and infrastructure features that are important to consider when designating routes. In addition, there are other State concerns specific to rail transport that are not entirely captured in the secondary list of risk factors described earlier. These include, but are not limited to, acceptable holding locations along the route, security and safety considerations, and using routes that have trained public safety officials.

Table 1
Characteristics of Routing

Highway	Current Rail
1. Requirement that carriers follow "Preferred Routes" for Highway Route Controlled Quantities of radioactive material.	No required rail network is identified. Key Routes are customarily used under industry recommended practices.
2. State routing agency identified as responsible for alternative route decisions.	No rail routing authority identified.
3. Reduce time in transit required.	No requirement for time in transit.
4. Explicit deviations from preferred routes are provided in regulations.	No explicit deviations have been identified.
5. Interstate highway system provides a large array of potential alternative routes.	The rail network is comparatively smaller and does not have as many suitable potential alternative routes.
6. Business decisions for specific transportation operations do not typically play a significant role in highway routing.	Business decisions for overall operations play an important role in rail routing because infrastructure is privately owned and maintained.

Elements Associated With the Potential Establishment of Regulations on Rail Routing

A regulatory basis for rail routing that is similar to the highway guidelines, if implemented, would have some potential issue areas to overcome. Listed below are some of the elements that would require further consideration:

- A regulatory basis would provide a standard approach for selecting rail routes and potentially support more consistency in rail routing.

- Rail routing regulations might facilitate the identification of a network of routes to be used for shipping spent nuclear fuel and high-level waste. This would allow the States to better target their resources for emergency preparedness training. Rail regulations are not necessary, however, in order to facilitate the identification of shipping routes. Given the industry's concern that a pre-established network of

routes might adversely affect the overall rail business operations by reducing options to coordinate movement of all commodities, striking a balance between meeting the needs of the States and those of the rail carriers might be a challenge.

- Following guidelines that are similar to those for highway might ensure that rail routes, like highway routes, are selected in order to minimize radiological impacts. Designating "preferred" rail routes, however, most likely would include high-quality mainline track. The result might be to concentrate the rail traffic through large population centers, which runs counter to the purpose of the preferred system of highway routes that can more readily avoid large population centers.

- Regulatory guidelines that are similar to those for highway might provide the States, or another entity, an opportunity and methodology to identify alternative rail routes. However, since rail lines are interstate in nature and are regulated exclusively by DOT, it might be difficult to establish a regulatory role for States or another entity to designate rail routes.

- Rail routing guidelines that are similar to those for highway might provide an opportunity to consider secondary risk factors during route selection. These factors may include emergency response and evacuation capabilities; location of special facilities such as schools or hospitals, and traffic fatalities and injuries unrelated to the radioactive nature of the cargo. On the other hand, a highly structured regulatory basis for selecting rail routes might remove much of the flexibility that is a requisite for rail operational efficiencies.

V. Summary

The purpose of this issue paper was to describe current rail regulations and practices regarding routing of rail shipments of spent nuclear fuel and high-level waste and to identify perspectives and concerns from involved parties in the transportation of these materials. The paper also compared aspects of the current highway routing regulations as they might apply to rail routing.

Several points can be summarized regarding the perspectives on current practices for rail route selection. First, the existing practices emphasize DOE coordination with affected States/Tribes, and other involved parties, but the timing of the coordination is critical for meaningful input into route selection. Second, there is a stated preference to narrow the number of acceptable routes, and to take into account safety factors that are not explicit in existing practices. Third, there are voluntary industry practices in place to enhance the safe transportation of hazardous materials while allowing the operational flexibility necessary for efficient rail transportation. Finally, there are operational efficiencies in applying a consistent approach to rail routing.

The comparative analysis of highway routing guidelines applied to rail identified several different characteristics between the two modes of transportation that make application of these guidelines to rail a challenge. A regulatory approach to rail routing would need to overcome many significant issues. Building on existing practices to establish a route selection process that addresses the concerns of involved parties presents a more immediate opportunity. Because of the sensitivity of routing spent nuclear fuel and high-level waste, consideration should be given to reviewing specific route selection criteria for application to rail routes.